NIH/NSF Workshop on
Visualization Research Challenges

Position Statement

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Visualization has made a lot of progress since the seminal NSF report "Visualization in Scientific Computing" was published in 1987. Real-time rendering of complex models on commodity hardware is now commonplace. Many theoretical aspects of data modeling and rendering have been studied in detail. And the commercial impact of visualization is big, especially for medical and geophysical applications. Yet, many people share the feeling that the field is becoming stagnant, that too much research focuses on incremental algorithmic improvements, and that there is a disconnect between research and applications. Moving forward, I see the following challenges ahead of us:

Connecting Visualization to the Sciences

Modern science is faced with an embarrassing mismatch between how much data we can measure and generate, and how much we have so far understood. Future discoveries will require close collaboration between scientists and computer scientist, and visualization plays an important role in providing unparalleled insight into scientific data and problems. Unfortunately, creators of visualization technology are often disconnected from the sciences, and scientists often do not have access to the latest visualization technology.

On one hand, visualization researchers need to get away from naval-gazing and playing with toy data sets. Visualization research with a clear application of the technology to the sciences needs to include discipline scientists as collaborators. On the other hand, scientists need to embrace the power of accessible and informative graphics for communicating scientific results both within the scientific community and to the general public.

It is the role of the government to bridge this gap between the sciences and computer science by emphasizing funding for interdisciplinary, innovative computing and visualization projects across the scientific frontier. Government also needs to emphasize education as a central ingredient in this endeavour.

Understanding Visual Communication

We need to focus on the principal goal of visualization: To convey information with graphical techniques. This simple statement raises many useful questions: How do we convey information effectively? How do we measure effectiveness? What are appropriate forms of visual abstraction? What forms of user interaction are most effective to gain insights? How can technology assist us in conveying information more effectively?

There are no clear-cut answers to these questions. However, it is clear that investigating the nature of visual communication requires a multi-disciplinary effort involving scientists, designers, computer scientists, cognitive scientists, and researchers in interaction design and human perception. Even more important is that the future challenges in visual communication will be driven by real-life problems that require effective visual communication solutions.

The government has the opportunity and obligation to encourage this kind of application-driven cross-disciplinary research that goes beyond what is now accepted and delves into the challenge of how we *really* make data communicative and accessible, especially at discipline boundaries and to the public.

Truth and Uncertainty in Visualization

Truth in visualization, imaging, and data representation is critical to scientific interpretation. What were the parameters used to generate this image? What does false color really mean? Has this image been digitally manipulated? How can we track what data was used in conjunction with what code version to produce a given visualization? A similar issue is the description and graphical representation of uncertainty. Data stored and mined from databases seldom has descriptors of calibration and inherent uncertainty attached as part of the metadata. Different fields visualize uncertainty in different ways—if at all—and uncertainty is seldom portrayed for the public.

The government needs to encourage the development of self-describing data structures to keep track of data manipulation and data provenance. It also needs to encourage research to develop standard graphical representations to visualize uncertainty.